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CORN JUDGING: STUDIES OF PROMINENT EAR CHARACTERS IN THEIR RELATION TO YIELD

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The time has perhaps come when this Station is able to draw some conclusions from experimental data as to what ear characters are associated with high yielding corn. Work was begun in a small way five years ago in the study of the relation of length of ear to yield. Four years ago it was extended to a study of the relation of shape of ear to yield, and later to the filling of the tip, the indentation of the kernel, the weight of ear and the effect of previous environment upon the value of seed corn.

It has been thought best to make a preliminary report of this work although the questions asked are a long way from being permanently answered. However, the answers recorded may turn some light upon corn judging, or the selection of seed corn.

In the study of these various characters the aim has been to have the groups compared differ widely with reference to one character only. Little or no attention has been paid to other characters except to have all sorts represented, the thought being that one character would offset its opposite, giving a fairly accurate comparison of the groups and the character studied.

Each group has consisted of from 25 to 100 ears and has been represented by a composite sample of seed made up of a few rows of kernels taken from each ear. While it is well known that ears of orn vary in their ability to yield from perhaps invisible, though beritable characters, in the numbers in which they were used in these tests it is presumed that such variation would be cared for; that is, that high and low yielding ears would be found in each group.

The size of the plots used in this work has been one-tenth acre. The conditions of growth as affected by previous treatment of soil have been quite uniform. For the last sixteen years not a furrow has been plowed, nor a pound of fertilizer put upon one plot without similar treatment being given the other plots of the series the same day.

In planting these test plots an excessive amount of seed has been used and the plots thinned to a uniform stand when the plants were six to eight inches high.

1. THE RELATION OF LENGTH OF EAR TO YIELD

Attention is called in the first place to the relation of length of ear to yield. In Table I is reported a test conducted in 1909 with four varieties of corn. Upon two of these plots corn of the third generation of continuous selection of long and short ears was used. Upon four plots, corn of the second generation, and upon four more, corn of the first generation.

TABLE I: The relation of length of ear to yield, 1909.

Variety	Average length	Average weight	Av. circ 2 in. from butt	Av. circ 2 in. from tip	Yield per acre	Excess length of long ears over short
	Ins.	Ozs.	Ins.	Ins.	* Bus.	Ins.
Clarage (*a*)	8.9	10.6	6.5	5.8	84.77	
Clarage (*a*)	6.6	8.8	6.7	6.1	79.15	
Gain for long ears					5.62	2.3
Leaming (*b*)	9.3	12.1	7.2	5.9	95.18	
Leaming (*b*)	7.1	9.9	7.4	6.4	90 41	
Gain for long ears					4 77	2.2
Darke Co. Mammoth (*b*)	9.7	13.3	7.0	6 2	99.47	
Darke Co. Mammoth (*b*)	7.2	10.9	7.5	6 9	92.70	
Gain for long ears					6.77	2.5
Reid Yellow Dent (*c*)	10.6	13.8	7.0		88.47	
Reid Yellow Dent (*c*)	8.2	11.7	7.2		82.28	
Gain for long ears					6.19	2.4
Leaming (*c*)	9.4	12.8	7.3		92.74	
Leaming (*c*)	7.8	10.4	7.4		90.21	
Gain for long ears					2.53	1.6
Average gain for long ears—10 plots in test					5.18	2.2

(*a*) Third generation of long and short ears.
(*b*) Second generation of long and short ears.
(*c*) First generation of long and short ears.
* Fall weights corrected to a uniform moisture content of 15 percent.

It will be observed that in every instance the long ears lead in yield, by amounts ranging from 2.53 to 6.77 bushels per acre, with an average of 5.18 bushels. It will be noted further that the greatest increase in yield comes in the group in which there is the greatest difference in length between the long and short ears, while the least increase in yield comes in the group in which there is the least difference in length.

However, differences in length of ear are not the only differences existing in these several groups. In Table II we have these same groups arranged so as to compare their differences with reference to other characters, as follows:

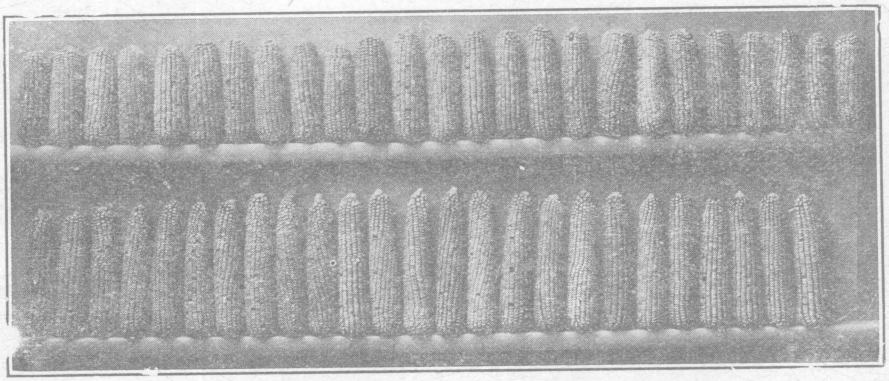
TABLE II: A study of the long and short ears reported upon in Table I with reference to length, weight, shape, circumference and proportion of circumference to length.

	Variety	Long or short ears	Excess in length Inches	Excess in weight Ounces	Excess in circumference (butt) Inches	Excess of butt circumference over tip circum. Inches	Excess in yield Bushels	Proportion of circum. to length Percent
1	Clarage	Long	2.3	1 8		0 7	5.62	73.0
2	Clarage	Short			0.2	0.6 *d*		101.5
3	Leaming (*b*)	Long	2.2	2.2		1 3	4.77	77.4
4	Leaming (*b*)	Short			0.2	1.0 *d*		104.2
5	Darke Co. Mammoth	Long	2 5	2 4		0.8	6 77	72.2
6	Darke Co. Mammoth	Short			0.5	0.6 *d*		104.2
7	Reid Yellow Dent	Long	2.4	2.1			6.19	66.0
8	Reid Yellow Dent	Short			0.2			87.8
9	Leaming (*c*)	Long	1.6	2.4			2.53	77.7
10	Leaming (*c*)	Short			0.1			94.9

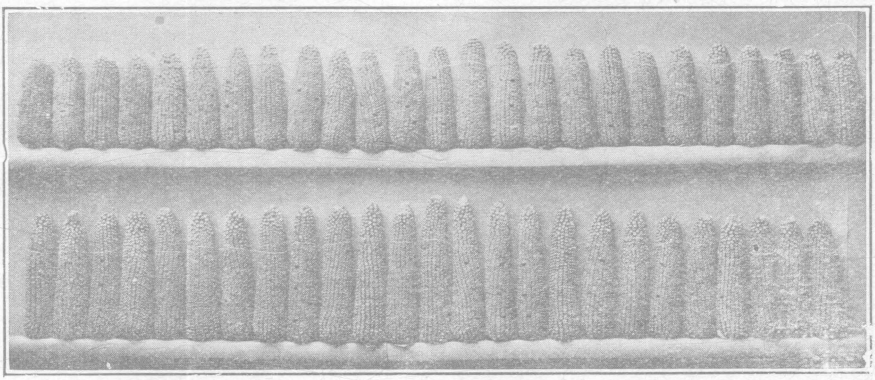
(*b*) Second generation. (*c*) First generation. (*d*) More cylindrical.

It is to be noted, as would be expected, that these groups of long ears average higher in weight of ear also. Is it possible that this excess in weight may have had as much to do with the increase in yield as has the length? That it has something to do with it is probable. Note, however, that, while the group of long ears (5) showing greatest increase in yield and greatest length also stands at the top in weight, there is another group (9) equaling it in weight, but at the other extreme in yield. The latter group is lacking in *length* as well as in yield.

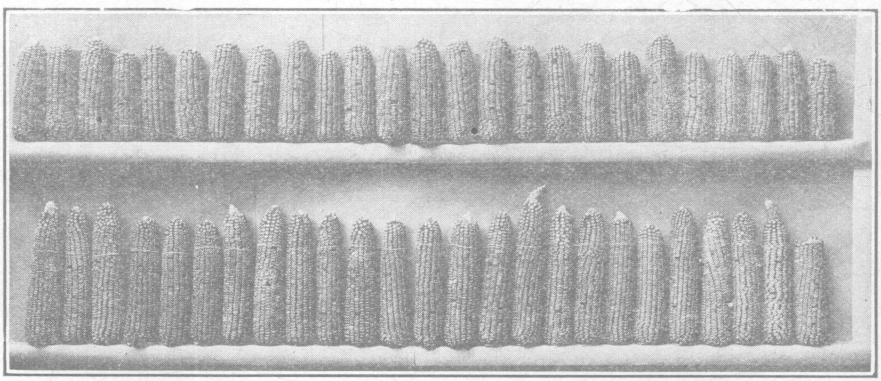
The short ears—and low yielders—invariably exceed the long ears in circumference. This would seem to indicate the impossibility of increasing the yield of short ears by increasing their circumference to make good their lack in weight, providing weight be a factor of significance in increasing yield.



Darke Co. Mammoth. Long and short ears.



Leaming. Long and short ears.



Clarage. Long and short ears.

TABLE III: The relation of length of ear to yield. Summary of 22 tests on 44 tenth-acre plots, 1905-1909.

Year	Variety	Long or short ears	Yield of shelled corn per acre * Bus.	Increase in yield Bus.
1909	Clarage	Long	84.77	5.62
	Clarage	Short	79.15	
	Leaming	Long	93.96	3.65
	Leaming	Short	90.31	
	Darke Co. Mammoth	Long	99.47	6 77
	Darke Co. Mammoth	Short	92.70	
	Reid Yellow Dent	Long	88 47	6 19
	Reid Yellow Dent	Short	82.28	
	Average gain for long ears			5 18
1908	Clarage	Long	68 22	0.45
	Clarage	Short	67 77	
	Leaming	Long	73 50	4 40
	Leaming	Short	69 10	
	Darke Co Mammoth	Long	78.25	5 06
	Darke Co Mammoth	Short	73 19	
	Average gain for long ears			3 31
1907	Clarage	Long	64.95	
	Clarage	Short	65 38	0.43
	Leaming	Long	63.41	3.15
	Leaming	Short	60.26	
	Reid Yellow Dent	Long	58.62	
	Reid Yellow Dent	Short	60 20	1.58
	Average gain for long ears			0 38
1906	Clarage	Long	66 88	8.12
	Clarage	Short	58.76	
	Leaming	Long	78.40	6.02
	Leaming	Short	72.38	
	Average gain for long ears			7.07
1905	Leaming	Long	97 05	4 20
	Leaming	Short	92.85	
Combined average of 22 tests, gain for long ears				3 97

* For 1909 ear corn corrected to 15 percent moisture content, 70 pounds of which will approximate shelled corn bushels.

In Table III is given a summary of the 22 tests conducted during the past five years in the study of long as compared with short ears. Many of these tests were in duplicate. Of those duplicated, the average of the two plots is given.

It will be noted that the long ears are in the lead each of the five years, although one year the lead is insignificant. The combined average of all the tests gives an advantage of 3.97 bushels in favor of the long ears.

Illustrations on page 216 give an idea of the character of the ears compared.

What has been the tendency of this continued selection of long and short ears upon the length of ear of the crop grown?

This continuous selection began with the Clarage corn in 1907. Thirty-nine short ears were selected, averaging 7.. inches in length, and 39 long ears averaging 9.4 inches. A composite sample, made up of a few rows of kernels from each ear, was planted upon tenth-acre plots, the plot from the short ears being grown beside the plot from the long ears each year, no effort being made to prevent inter-crossing.

The length of each ear of corn grown from these selections was measured. The average length of ear from the short ears was 7.12 inches; from the long ears 7.56 inches: a difference of .44 inch. The length was measured about a month after husking and before the ears were fully shrunken, while the seed ears planted each year have been measured in the spring, shortly before planting.

For the plantings of 1908 and 1909 short and long ears were selected from the preceding crop of the same class. The crop was not measured in 1908, but was in 1909, as in 1907, when the average length of ear was 6.87 inches for the short ears and 7.92 inches for the long ears. A difference of 1.05 inches in 1909 as compared with 0.44 in 1907.

It should perhaps be stated that ears of all lengths, including nubbins, were measured both years.

TABLE IV. Variation in length of ear in seed and progeny.

Year	Seed used			Crop harvested			* Yield per acre		
	Long ears, Av. length Inches	Short ears, Av. length Inches	Difference Inches	Long ears, Av. length Inches	Short ears, Av. length Inches	Difference Inches	Long ears Bus.	Short ears Bus.	Difference Bus.
1907.....	9.43	7.11	2.32	7.56	7.12	0.44	64.95	65.38	−0.43
1909.....	8.90	6.60	2.30	7 92	6.87	1.05	84.77	79 15	+5.62
Comparing 1909 with 1907	−0.53	−0.51	−0.02	+0 36	−0 25	+0.61	+19 82	+13.77	+6.05

* Shelled corn for 1907. Ears, corrected to 15 percent moisture in 1909.

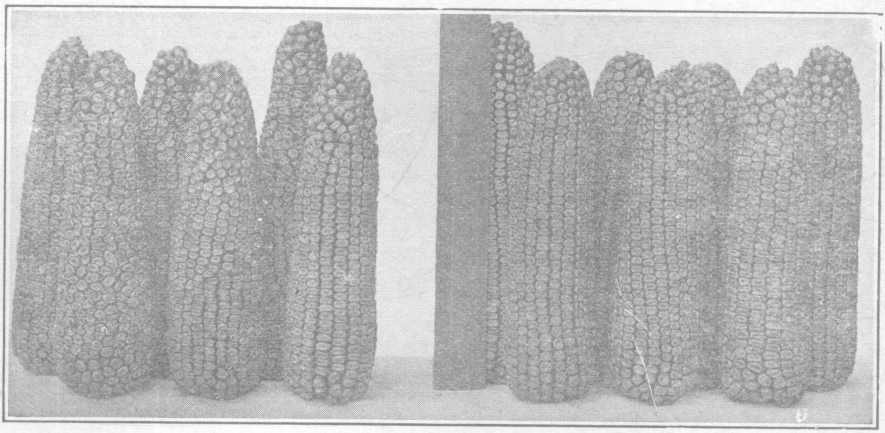
While the seed of the long ears used in 1909 is not of as great average length as that of 1907, this fact would seem to be due to a matter of environment. At any rate the inherent character seems to be present, for it is asserted in the progeny.

That the average length of ear can be quite rapidly changed is probable. The plant breeder will be interested in accounting for this change. Are we adding together the slight fluctuations discoverable year by year, or did we have in the first selection all we now have in these heritable characters, the advance made being due, not to the addition, little by little, of the character in question, but to the purification of the type by the weeding out of the opposite character—to subtraction rather than addition? The practical corn grower will be interested in the fact, though possibly not in the theory.

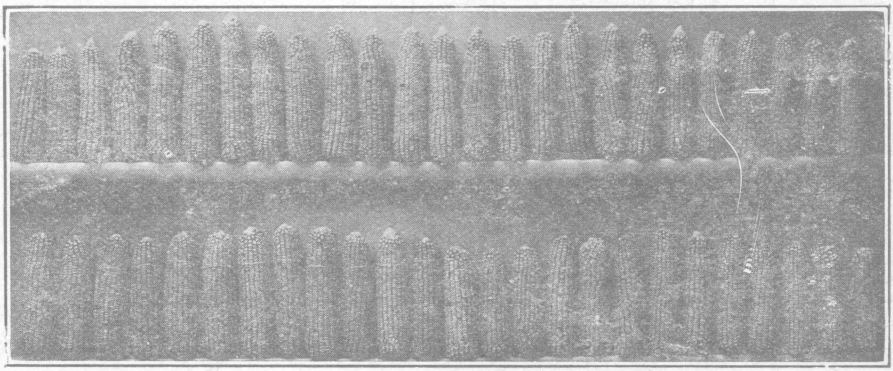
Conclusion: If a given quantity of seed corn be divided into two groups, one composed of ears below the average length and the other above, the longer ears will out-yield the shorter. We have no evidence that selection for extremely long ears increases the yield above those of medium length. The difference in yield thus far has seemed to be due to a lessened yield resulting from the selection for short ears, rather than an increased yield from the selection for long ears.

2. THE RELATION OF SHAPE OF EAR TO YIELD

If there has been one ear character insisted upon more strongly than another in the corn judging of the country it has been that of cylindricity. In 1906 this Station began some studies of the relation of shape of ear, as regards cylindricity, to yield. In the selection of varieties to be used in these tests the aim was to include varieties having quite different tendencies; varieties in which the cylindrical ear predominated, and varieties in which the decidedly tapering ear was the rule. Accordingly, what I may call the Ohio, or old type of Leaming corn has been used throughout the test as representing the tapering varieties, and the Darke County Mammoth, another fairly distinct Ohio strain, as representing the varieties tending toward the cylindrical ear. During two of the four years of this test Reid Yellow Dent has also been included. Cylindrical and tapering ears from each variety have been compared side by side, selected to vary as widely in each direction as could well be found in corn that would pass at all for seed corn. A consultation of tables and illustrations will give an idea of the type of corn tested.



Leaming. Cylindrical and tapering ears.



Darke Co. Mammoth. Cylindrical and tapering ears.

TABLE V: The relation of shape of ear to yield, 1909.

Variety	Cylindrical or tapering	Average		Av. circum. 2 inches from		Yield per acre *Bus.
		Length Ins.	Weight Ozs.	Butt Ins.	Tip Ins.	
Leaming (*b*)	Cylindrical	8 1	11 4	7 2	6.3	93.71
Leaming (*b*)	Tapering	8.4	10 3	7 0	5 6	93.45
Gain for cylindrical ears						0.26
Darke Co. Mammoth (*b*)	Cylindrical	8 2	12.8	7.3	6.8	94 43
Darke Co. Mammoth (*b*)	Tapering	8.8	11 5	7.0	6 0	93 64
Gain for cylindrical ears						0.79
Reid Yellow Dent (*c*)	Cylindrical	9.3	13.8	7.2	6.5	90 08
Reid Yellow Dent (*c*)	Tapering	10.0	12.7	7 2	5.5	85.97
Gain for cylindrical ears						4.11
Leaming (*c*)	Cylindrical	8.2	12.0	7.7	6.5	88.46
Leaming (*c*)	Tapering	8 8	11 8	7.4	5.6	89.31
Gain for tapering ears						0.85
Average gain for cylindrical ears						1.08

(*b*) Second generation of cylindrical and tapering ears.
(*c*) First generation of cylindrical and tapering ears.
* Corrected to a uniform moisture content of 15 percent.

In Table V is given the result of the comparison of cylindrical with tapering ears in the tests of 1909. It will be discovered that the greatest variation in the character studied is found in the case of Reid Yellow Dent selections, and only in this variety is there a variation in yield of moment. This variation is in favor of the cylindrical ears.

TABLE VI: A study of the cylindrical and tapering ears reported upon in Table V, with reference to length, weight, shape, circumference and proportion.

Variety	Cylindrical or tapering	Excess in length	Excess in weight	Excess in circum. (butt)	Excess of butt circ. over tip circ.	Excess in yield	Proportion of circ. to length
		Inches	Ounces	Inches	Inches	Bushels	Percent
Leaming (*b*)	Cylindrical		1.1	0.2	0.9	0.26	88.9
Leaming (*b*)	Tapering	0.3			1 4		83.3
Darke Co. Mammoth	Cylindrical		1.3	0.3	0.5	0.79	89.0
Darke Co. Mammoth	Tapering	0.6			1.0		79.6
Reid Yellow Dent	Cylindrical		1.1	0	0 7	4.11	77.4
Reid Yellow Dent	Tapering	0.7		0	1.7		72 0
Leaming (*c*)	Cylindrical		0.2	0.3	1.2		93 9
Leaming (*c*)	Tapering	0 6			1 8	0 85	84 1

(*b*) Second generation. (*c*) First generation.

The variation in the different ear characters of the variety types is brought out in Table VI, but this table offers little explanation of the results secured. While the cylindrical exceed the tapering ears in weight, the greatest excess in weight is not associated with the greatest excess in yield per acre.

TABLE VII. The relation of shape of ear to yield. Summary of 18 tests on 36 tenth-acre plots, 1906-1909.

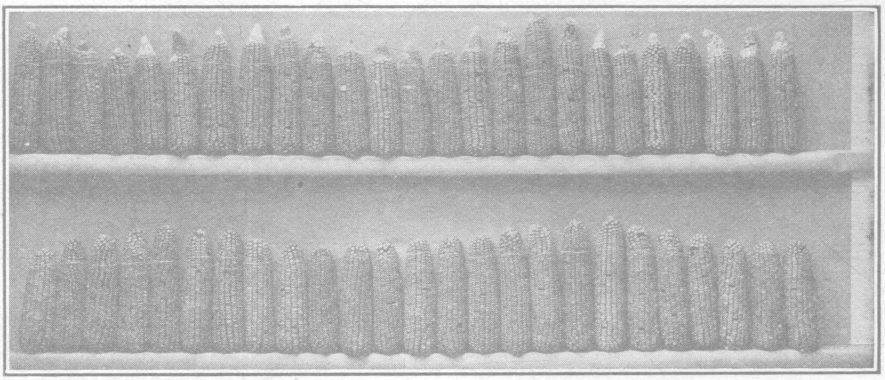
Year	Variety	Cylindrical or tapering	Yield of shelled corn per acre * Bus.	Increase in yield Bus.
1909	Leaming	Cylindrical	91.08	
	Leaming	Tapering	91.38	0.30
	Darke Co. Mammoth	Cylindrical	93.43	0.79
	Darke Co. Mammoth	Tapering	93.64	
	Reid Yellow Dent	Cylindrical	90.08	4.11
	Reid Yellow Dent	Tapering	85.97	
	Gain for cylindrical ears			1.08
1908	Leaming	Cylindrical	76.16	1.47
	Leaming	Tapering	74.69	
	Darke Co. Mammoth	Cylindrical	69.61	
	Darke Co. Mammoth	Tapering	71.51	1.90
	Gain for tapering ears			0.21
1907	Leaming	Cylindrical	59.81	
	Leaming	Tapering	60.92	1.11
	Darke Co. Mammoth	Cylindrical	63.74	2.64
	Darke Co. Mammoth	Tapering	61 10	
	Reid Yellow Dent	Cylindrical	60.49	
	Reid Yellow Dent	Tapering	60.91	0 42
	Gain for cylindrical ears			0 37
1906	Leaming	Cylindrical	70.13	
	Leaming	Tapering	76 23	6.10
	Darke Co. Mammoth	Cylindrical	73.34	
	Darke Co. Mammoth	Tapering	76.72	3.38
	Gain for tapering ears			4.74
'06-'09	Combined average of 18 tests, gain for tapering ears			0.87

* For 1909, ear corn corrected to 15 percent moisture.

In Table VII is given the summary of 18 tests, extending over four years. In two of these years the cylindrical ears lead slightly, while in two the tapering ears lead. The combined average shows a gain of 0.87 bushel in favor of the tapering ears. It is evident at a glance that there is not the consistent variation in yield in favor of either character that is found in the case of the long and short ears. In considering these data it seems that we are dealing with a character of minor importance, and hence the conclusion is forced upon one that until more decisive evidence is forthcoming, it is unwise to discriminate to any great extent in favor of either the tapering or cylindrical ear.

3. BARE VS. FILLED TIPS

In 1907 a test was started in which ears of Clarage corn having ¾ to 1½ inches of bare cob at the tip of the ear were compared with ears completely filled out. In the ear-row tests of several years preceding it had been found that the high yielding ears were fully as apt to be bare at the tip as to be filled out, and accordingly the above test was started to study the relation of this character to yield in a larger way. The first year the average yield of the two plots planted with bare-tipped seed was 58.21 bushels, and of the plots planted with the filled-tipped seed, 57.79 bushels; a slight gain of 0.42 bushels for the bare tips.



Clarage. Filled and bare-tipped ears.

From each of these types 25 similar ears were selected for planting in 1908—bare tips from bare tips and filled tips from filled tips. The results the second year were in favor of the filled tips, with a gain of 1.45 bushel, the yields being 64.07 bushels for the bare tips and 65.52 bushels for the filled tips.

The selection was continued in like manner for the test of 1909, resulting in a gain of 2.19 bushels in favor of filled tips, the yields being 84.37 and 86.56 bushels per acre.

Tabulating the results for the three seasons' work, they stand as follows:

TABLE VIII: Three crops from bare and filled tips.

Year	Bare or filled tips	Yield of shelled corn per acre Bus.	Gain per acre Bus.
1907	Bare	58.21	
	Filled	57.79	
	Gain for bare tips		0.42
1908	Bare	64.07	
	Filled	65.52	
	Gain for filled tips		1.45
1909	Bare	84.37	
	Filled	86.56	
	Gain for filled tips		2.19
	Average gain for filled tips		1.07

In the light of the above facts the tendencies of deliberate selection for bare tips would seem to be in the direction of a decreased yield. The yield of the original selections was slightly in favor of the bare tips, indicating that the foundation ears of the bare-tipped group were the equal, at least, of the filled-tipped. Their gradual falling off in yield as compared with the latter, seem to show the above mentioned tendency.

It is of interest to note the habit of these groups to reproduce their characteristic tip. The following table gives information regarding the seed ears used in 1909 and the crop procured therefrom.

TABLE IX: Bare tips vs. filled tips. Crop of 1909.

THE SEED USED.	BARE TIPS	FILLED TIPS
Average length of ear	8.4 ins.	8.0 ins.
Average weight of ear	9.4 ozs.	10.6 ozs.
Average circumference	6.6 ins.	6.7 ins.
Average percent of grain	83.6 %	84.5 %
THE CROP HARVESTED		
Yield per acre	84.37 bus.	86.56 bus.
Average length of ear	7.70 ins.	7.52 ins.
Average length of bare tips	1.03 ins.	0.53 ins.
Ears having filled tips	3.7 %	20.1 %

It will be observed that only 3.7 percent of the ears grown from the seed ears having bare tips had completely filled tips, while 20 percent of the ears grown from filled-tipped seed had completely filled tips. As might be expected the greater part of the ears and nubbins in both lots were bare at the tip. The sum total of inches of bare tips divided by the total number of ears harvested gives an average of 1.03 inch of bare tip *per ear* for the bare-tipped lot and 0.53 inch for the filled-tipped lot.

The average length of ear was greater by 0.18 inch in the case of the crop from the bare, as compared with the filled tips. If, however, we count only that portion of the ear length which is filled with grain, the filled tips lead by 0.32 inch.

Other things being equal, the continued selection of ears having ¾ to 1½ inch of bare cob at the tip will tend to reproduce ears having this character, reducing the percentage of ears having filled tips, and to reduce the yield.

4. ROUGH VS. SMOOTH-DENTED EARS

The relation of the indentation of kernel to yield has been studied both in ear-row work, and also in plot work, in which rough and smooth types of the same variety were compared side by side. The results of the ear-row tests have been in favor of the smooth type, showing a gain of 2.84 bushels per acre over the rough type. The ear-row tests extend over a period of five years.

The plot work with these types was started in 1908. The results for the two years are as follows: For 1908, a gain of 0.99 of a bushel in favor of the rough-dented ears. For 1909, a gain of 2.17 bushels in favor of the smooth-dented ears. This reversal of results may be significant, or it may not. Two or three more years of this continuous selection will give some important information. The fact that the rough ears were superior the first season tested would indicate that they were inherently the equal of the smooth selections.

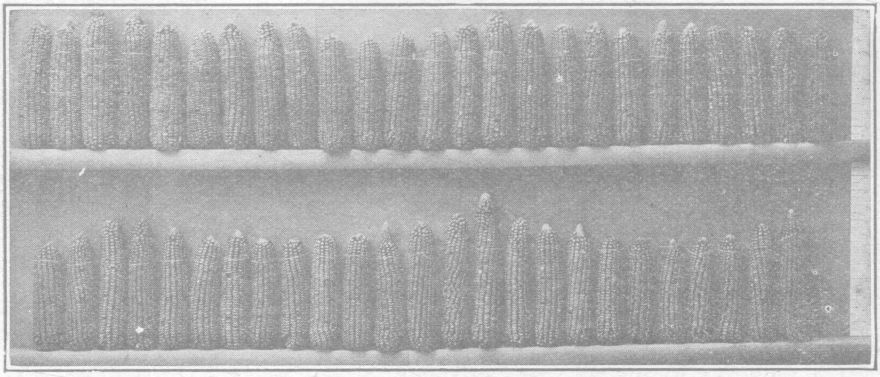
The character of the seed ears used in 1909 is recorded in the following table:

TABLE X: Rough vs. smooth-dented ears. Crop of 1909.

	ROUGH	SMOOTH
Average weight of ears	10.8 ozs.	9.6 ozs.
Average length of ears	8.3 ins.	8.1 ins.
Average circumference of ears	6.8 ins.	6.3 ins.
Average percent of grain	84.2	80 7
Proportion of circumference to length	81.9 %	77.7 %
Yield per acre	88.69 bus	90.86 bus

It will be noted that the rough-dented ears exceed the smooth in weight, length, circumference and percent of grain. Several of these characters, when studied under conditions in which they were dominant, have favored an increase in yield; but in a modified form, and associated with the more pronounced character of roughness in indentation, they have given way to the smooth type.

Taking into consideration both the ear-row and the plot tests, it seems that the evidence at present is in favor of the smoother-dented ears as being the more productive.



Clarage. Smooth and rough-dented ears.

5. HEAVY VS. LIGHT SEED EARS

As reported in Circular 71, this Station had found the heavier ears in its ear-row tests outyielding the lighter. This was for the years 1904-1906. Bringing this report down to 1909 these tests continue to tell the same story, the heavier ears giving a slight advance in yield.

It should be stated that extremes were not sought for in the selection of seed ears for this ear-row work, but in the selection of otherwise desirable ears there was some variation in weight. Of about 400 ears tested, if the heaviest 40 percent be thrown into one group and the lighest 40 percent into another, we find the average difference in weight of these two groups to be 2.46 ounces per ear, and the difference in yield to be 2.08 bushels per acre.

With the numbers involved and the varying conditions of growtn during the different seasons it would seem that this variation in yield might safely be attributed to the variation in weight of seed ears.

In 1908 the Station started a tenth-acre plot test in which 50 representative heavy ears were compared with an equal number of lighter ears. The test was continued in 1909 with heavy ears selected from the crop grown from heavy ears in 1908 and with the light ears selected in a similar manner.

The yields for the two seasons' tests are as follows:

TABLE XI: Yields of heavy and light ears.

Year	Heavy or light ears	Yield of shelled corn per acre Bus.	Gain per acre Bus.
1908	Heavy	65.73	
	Light	65.10	
	Gain for heavy ears		0.63
1909	Heavy	91.13	
	Light	87.80	
	Gain for heavy ears		3 23
	Average gain for heavy ears		1.93

This plot test must continue longer before it will be safe to draw conclusions from it alone. Did it not confirm the ear-row tests of the past five years we should not have recorded it at this time. The two tests taken together, however, would seem to indicate a value for the heavy-weight ear. This sort of ear must not be confused with the overgrown and immature ear of large size.

It will be noted that the heavy ears take a more decided lead in 1909. It is proper that the measurements of these two groups of ears as used in 1909 be recorded, that they may be compared with other ears used in the other tests. Also see illustration.

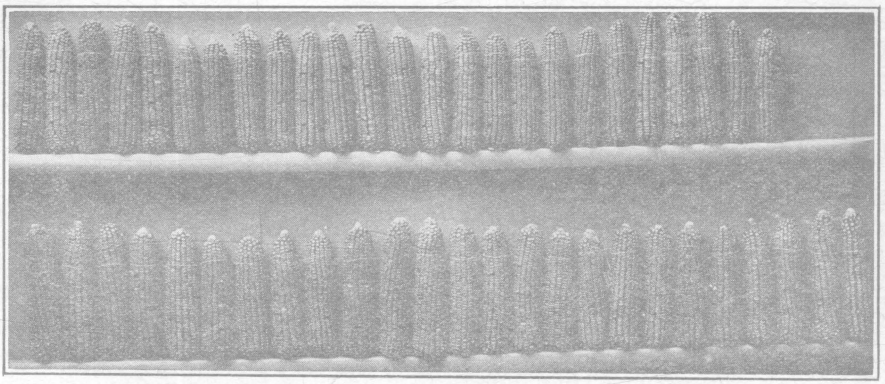
TABLE XII: Heavy vs. light ears. Crop of 1909.

SEED USED	HEAVY	LIGHT
Average weight of ears	11.6 ozs.	9.4 ozs.
Average length of ears	8.6 ins.	8.3 ins.
Average circumference of ears	6.9 ins.	6.2 ins.
Proportion of circumference to length	80.2 %	74.7 %
Average percent of grain	84.2 %	80.1 %
CROP HARVESTED		
Yield per acre	91.13 bus.	87.90 bus.
Average weight of ears	11.75 ozs.	11.03 ozs.

In computing the average weight of ears in the crop harvested, upwards of 1000 ears were included in each group.

In considering the above data it will be noted that weight of ear and percent of grain both vary widely. It may be asked, which, if either, is responsible for the variation in yield? Our tests to date show that weight of ear is a better indication of high yielding seed ears than percent of grain.

For instance: If the same 400 seed ears above mentioned be divided into two groups, one containing the 40 percent having the highest percent of grain, the other the 40 percent having the lowest percent of grain, we find the former seed ears averaging 86.0 percent of grain and yielding 81.9 bushels per acre, and the latter averaging 81.8 percent of grain and yielding 83.1 bushels.



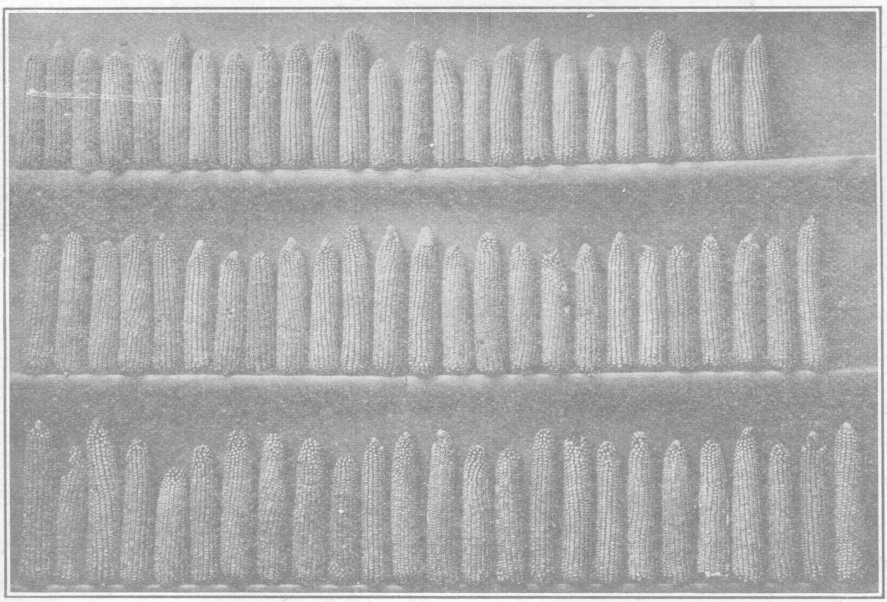
Clarage. Heavy and light ears.

In order to test this ear character under different conditions, a tenth-acre plot test was started this season, 1909. Two hundred fairly good seed ears were chosen. Each ear was shelled separately and its percent of grain determined. The 20 ears having the highest percent of grain were thrown into one group and the 20 having the lowest percent into another. The former averaged 86.09 percent grain and the latter 79.67 percent. The yield per acre as weighed from the field is 104.00 bushels for the high percent strain and 107.57 bushels for the low. At this writing we do not have the shelled corn records. This test will be continued, the selection of high and low percent grain being continuous.

For the present it may be said that weight of ear is worthy of attention in the selection of seed ears.

6. THE EFFECT OF THE PREVIOUS ENVIRONMENT OF CORN UPON ITS VALUE AS SEED

There have long been prevalent among corn growers quite definite ideas as to the propriety of taking seed corn grown under favorable conditions of soil to less favorable conditions, and vice versa. In order to study the effect of previous conditions of growth upon future crops, this Station began a test in 1907 in which seed corn selected in 1906 from the best manured plot in the fertility work of the Station was compared with corn from an adjoining unfertilized plot. It should, perhaps, be stated that the fertility plots mentioned have been under the same treatment—the one well manured for two crops of the 5-crop rotation, the other continuously unfertilized—for the past sixteen years.



From bottom to top: one, three and five plant strains.

The two lots of seed corn will be hereafter described as "rich" and "poverty" strains of Clarage corn. They were grown on plots side by side, under very favorable soil conditions in our regular variety test plots. In 1908 and 1909 new seed was secured from the original fertility plots and tested as in 1907.

Beginning in 1907 the rich and poverty strains have been grown upon the corresponding plots in the fertility work, the selection being continuous.

The results of the three tests thus far conducted are not convincing. In 1907 the poverty strain led by 0.98 bushel. In 1908 the rich strain by 2.32 bushels. In 1909 the poverty strain led again by 3.80 bushels. The average gain for the poverty strain is accordingly 0.82 bushel per acre.

Attempting to get an answer to the same question from another angle, this Station has been comparing seed ears selected under conditions of normal stand with ears selected without knowledge of stand, i. e., from the wagon. In each instance the best seed ears readily obtainable were selected. Averaging the tests of 1906-1908, the seed ears selected under normal stand have given an increase in yield of 2.36 bushels per acre.

In 1909 this test was changed to make possible more accurate knowledge as to the conditions of stand. Seed ears for use in this work were selected from the "thick and thin" planted plots of 1908. For this use the twenty-five largest and best ears obtainable were selected from the plots upon which corn was growing at the rates of one plant per hill, three plants per hill and five plants per hill. These three lots of seed known as the one, three and five plant strains were planted on adjoining plots and in duplicate. The conditions of growth in 1909 were made as uniform in every way as possible. Interplanted with these three strains were the regular check plots. The yields given in the table below are corrected to a moisture content of 15 percent.

TABLE XIII: One, three and five plant strains of corn. Crop of 1909.

Strain	Average weight of ears Ounces	Average length of ears Inches	Average circum. of ears Inches	Proportion of circum. to length Percent	Average percent of grain	Yield per acre Bus.
One plant	12 0	9 4	6.9	73.4	82 5	91.49
Three plant	10 0	8.8	6.6	75.0	84 0	91.74
Five plant	8 0	7.9	6 3	79.7	82.5	92.58

The differences in yield are of course slight. It is of interest to note, however, that seed ears which are inferior in size and appearance (see illustration as well as table) because of environment are not necessarily inferior in hereditary value. It would seem to be important to know something of the conditions under which an ear of corn is grown before undertaking to tell very much about its value as a seed ear.

In the latter test, as in the rich and poverty strain test, it is evident that under the unfavorable conditions of fertility or stand the ears will be small, and few or none grade as seed ears. May it not be possible, however, that if the cream be skimmed off, one will get a higher quality of seed after all? Whether nature, under "the survival of the fittest," will bring to the front individuals of superior merit, or not, remains for future tests to determine.

7. THE GERMINATION BOX AS AN INDEX TO HIGH YIELDING EARS

It is a fact well known to everyone who has conducted germination tests with corn that the kernels from some ears germinate much quicker than from others; that in a group of 100 ears, not infrequently a half dozen or more will be out of the soil, and an inch or two high before the laggards appear above ground. Is this precocity an indication of superiority as regards yield? Will the "first ups" out yield the "last ups?" If they could be depended upon to do so, as has sometimes been asserted, the germination box could be substituted for the ear-row test, and not only much labor be saved, but more rapid strides taken in the direction of corn improvement.

In order to turn light upon this question a test was conducted in 1907. Six hundred ears were germinated in a shallow box filled with clay loam soil, the kernels being covered with an inch of soil. Data were gathered regarding the order of the appearance of the plants above ground twice in 24 hours. In each lot of 150 ears the 10 ears which came though the soil first were put in one class and the 10 which came up last in another class. Only those ears were considered of which every kernel planted grew. The average variation in the appearance of the plants above ground of the two lots was 48 hours.

A composite sample of seed was made up representing each ear, and two tenth-acre plots were planted from each lot.

The yields of these plots were as follows:

TABLE XIV: First ups and last ups.

	Class	Yield of shelled corn per acre	
Plot No. 46	First ups	63.71	Bushels
Plot No. 47	Last ups	66.90	"
Gain for Last ups		3 19	"
Plot No. 50	First ups	66 66	"
Plot No. 51	Last ups	69.16	"
Gain for Last ups		2 50	"
Average gain for Last ups		2.84	

The same differences in the rapidity of germination were noted in the field as in the germination box. These differences appear to be due to the comparative hardness of the kernels from the different ears and their consequent capacity for rapidly absorbing moisture. The larger the proportion of soft, white starch in the kernel the more rapidly it takes up water and the sooner it germinates. Variation in the thickness and imperviousness of the hull may have something to do with it also.

The germination box is exceedingly useful in weeding out ears injured by the careless handling of seed corn. The more nearly the conditions of growth in the box conform to field conditions, the more valuable will be the test. Further than this the germination test seems to have little value.

As a matter of experiment in its ear-row tests, this Station has found that where enough seed has been planted so that a uniform stand of plants could be had by thinning, a considerable falling off in percent of germination in individual ears has been no sure indication of inferiority in yield. Dividing the ears tested in its ear-row work for the last five years into two classes, in one putting that 40 percent of the ears showing best germination, and in the other the 40 percent showing poorest; the average yield of the two lots has varied but .68 of a bushel. This variation is in favor of the lot showing the best germination.

8. ADAPTABILITY: OF FIRST CONSIDERATION IN THE SELECTION OF SEED CORN

This is true as applied to varieties, and to individual ears within a variety. The loss Ohio corn growers sustain by purchasing unacclimated and ill adapted varieties of corn for seed uses is very great. It is to be feared that the stimulus given the seed trade by the corn shows, with their high prizes, is increasing the trouble from this source. As illustrating the losses incident to the use of varieties not acclimated to the locality where grown, attention is called to the following table which gives the yield per acre, together with some idea of the quality of the product, of seven different varieties as grown at this station in 1908. Similar results are occur ring every year in our variety test work and are duplicated upon many corn farms in every county in this state.

TABLE XV: Variation in adaptability of different varieties of corn; 1908.

Variety	Date of tasseling	Average height of plants Ft. Ins.	Percent of moisture as husked	Bushels of shelled corn per acre	Weight per bu. of shelled corn Lbs.	Pounds of stover per acre
Hildreth Yellow Dent, Kansas	Aug. 8	11—6	33.7	57.69	49.00	6,720
Reid Yellow Dent, Illinois	Aug. 1	10—6	25.0	67.19	50.00	4,700
Reid Yellow Dent, Southern Ohio	July 30	10—0	22.4	69.91	50.50	4,240
Darke Co. Mammoth, Southern Ohio	July 28	9—10	21.0	73.12	53.50	4,167
Leaming (early strain) Southern Ohio	July 27	9—9	20.7	74.78	52.50	3,770
Ohio 84-6055, O. A. E. S.	July 24	9—10	18.7	78.76	54 50	3,760
Clarage, O. A. E. S.	July 24	9—6	17.8	68.07	54.50	3,533

The above table calls for little comment. While the figures given seem to discourage the introduction of new varieties, they apply to the wholesale introduction only. It is possible to try out new varieties of promise in a small way, and by the careful selection of ears from plants which come nearest to being adapted to local conditions, to gradually acclimate any variety which seems to have merit.

The variation in individual plants which makes this sort of improvement possible will be appreciated by any one who has conducted an ear-row test and kept records regarding the data recorded in the following table:

TABLE XVI: Variation in individual ears of the same variety as judged by their progeny in ear-row work; 1909.

Ear number	Date of tasseling	Date of silking	Height of plant Ft. Ins.	Height of ears Ft. Ins.	Percent of moisture at husking	Yield per acre corrected to 15 % M. Bus.
9002	July 30	Aug. 4	10—2	4—2	30.8	86.30
9067	July 23	July 28	7—5	2—6	23.0	50.84
9015	July 29	Aug. 4	9—10	3—11	31.6	77 13
9025	July 22	July 27	8—8	3—2	25.2	76.16
9011	July 28	Aug. 4	9—2	4—0	32.9	93.19
9063	July 24	Jnly 29	8—4	3—3	24.8	67.17
9016	July 30	Aug. 4	9—8	4—7	32.1	87.08
9007	July 24	July 29	8—9	3—0	26.9	91.64
9061	July 28	Aug. 1	9—7	3—9	29.2	73.61
9056	July 23	July 29	8—1	3—4	28 5	68.35
9013	July 28	Aug. 2	8—8	3—6	27.0	80.02

The Ohio farmer should grow in a large way only such varieties as have proved their worth for a series of years under such conditions as prevail in his immediate locality. If satisfactory native varieties are not obtainable, approved new varieties may be tested in a small way and gradually adapted to local needs as indicated.

9. A FULL STAND OF PLANTS

The importance of having a full stand of plants is appreciated by more corn growers than have yet been able to attain it. As to what constitutes a full stand, there is a considerable difference of opinion. This difference of opinion is, to some extent, a difference of fact, for under different conditions of soil and climate different stands are needed. And yet it is probable that much of this difference of opinion is mere opinion, without any basis of fact.

TABLE XVII: Thick and thin planting of corn.

No. plants per hill	Average weight of ears	Percent of		Yield of shelled corn per acre	Pounds stover per	
		Nubbins	Barren plants		Acre	Bushel of corn
1904						
1	.635	11.5	1 8	30 79	1,750	56.8
2	.578	21.3	1.9	48 77	2,500	51 3
3	.557	21.1	3.9	60.46	3,610	59 7
4	.502	27.1	5.1	65.40	3,775	57.7
5	.431	37.1	10.3	59.73	4,090	68.5
1906						
1	.701	7 7	2 6	33.01	2,680	81.2
2	.676	9.9	2 3	59 68	3,870	64.9
3	.594	15.7	2.9	73 96	4,350	58.8
4	.507	25.2	5.7	78 47	4,580	58.4
5	.429	42.8	9 6	78.14	5,500	70.4
1907						
1	.763	10.1	1.9	28.76	2,848	99 0
2	.623	19.6	3 2	41.14	3,791	92.2
3	.474	34.3	7.9	40.09	4,147	103 4
4	.405	48 0	15.9	39.09	5,437	113 5
5	.354	58.5	24 5	35.91	5,695	158.6
1908						
1	.627	11 8	2 6	33 32	2,660	79.8
2	.625	12.5	2.0	51.47	3,400	66 1
3	.549	6.9	1.1	62.62	3,870	61.8
4	.459	13.4	2 9	64.85	4,190	64.6
5	.395	21.0	2 9	67.40	4,590	68.1
1909						
1	.740	18.1	1.1	*37.67	3,300	88.4
2	.780	8.8	0.8	66.57	4,710	70.8
3	.710	11.6	1.8	85 30	5,670	66 5
4	.622	12.6	5.3	93.78	6,300	67.2
5	.565	20.6	6.9	102.96	6,990	67.9

* Yield for 1909 in ears reduced to a 15 percent moisture content.

As a guide for such conditions as those which obtain at this Station, namely, a silt loam soil of the Waverly series, manured on a clover sod with 8 to 12 tons of phosphated manure from the stable or manure shed, the following table is inserted giving the yields of shelled corn per acre at thicknesses of planting ranging from one to five plants per hill, in hills 42 inches apart each way, for five different seasons, and the average of four seasons' tests. The year 1909 is omitted from the average since the shelling records are not yet available.

In these tests sufficient seed was planted that exact stands could be secured by thinning.

TABLE XVII: Continued. Average for four years, 1904, '06, '07, '08.

No. of plants per hill		Average weight of ears	Percent of		Yield of shelled corn per acre	Pounds stover per	
Hill	Acre		Nubbins	Barren plants		Acre	Bushels of corn
1	3,555	.68	10 3	2 2	31.47	2,484	78 9
2	7,110	.621	15.8	2 4	50.26	3,390	67 4
3	10,665	.545	19.5	4.0	59.28	3,994	67.4
4	14,220	.463	28.4	7.4	61 95	4,495	72.6
5	17,775	.402	39.8	11.8	60 29	4,969	82.4

It will be noted that the highest average yield of corn has been secured from four plants per hill, or 14,220 plants per acre. That five plants per hill have given a higher yield than three; however the average size of ears is much smaller and the percent of nubbins very large. For some uses this would be a disadvantage, but for shock feeding the small ears and the finer stover would be acceptable.

Very extensive tests with different distances between hills, and different numbers of plants per hill, have been conducted by the Illinois Experiment Station. The average of their large number of tests in six different localities in Illinois shows the highest yields to have been secured from an average stand of 11,107 plants per acre, and the second highest yields from 12,130 plants per acre.

Stands of 12,400 plants per acre may be had from three plants per hill, in hills 36x42 inches. With present information this may be regarded as perhaps a full stand for good soil conditions.

SUMMARY

While the tests herewith reported will be continued indefinitely, with some modifications, for the present they seem to show:

1. That the selection of seed ears of less than normal length, for a given variety or locality, will reduce the yield and, if the selection be continuous, gradually shorten the length of ear.

2. That shape of ear as regards cylindricity is a matter of less importance than many other of the prominent ear characters. While the tapering ears have, upon the average, led slightly in yield, the variation is neither important nor consistent, and more evidence is needed before a pronouncement can be made for either type.

3. That the continuous selection of seed ears having an inch to an inch and a half of bare cob at the tip will increase the average amount of bare cob at the tip, diminish the total number of ears having completely filled tips, and decrease the yield of shelled corn per acre.

4. That so far as indentation of kernels is concerned, ears comparatively smooth—crease-dented—have proved somewhat superior in yield to the rough-dented ears.

5. That, conditions of growth being equal, weight of ear, as made up of slight increases in length, circumference and amount and density of grain and cob, favors an increase in yield and is worthy of consideration in the final selection of seed corn.

6. That a knowledge of the previous conditions of growth is helpful in estimating the value of seed corn. And further, that seed for use under given conditions would better be selected under slightly inferior, rather than a very much superior environment.

7. That the germination box can hardly be expected to pick out seed ears of superior hereditary merit. Its work is completed in atoning, in part, for carelessness in the handling of seed corn.

8. That the main crop of corn on every farm should be planted with varieties known to be productive and acclimated, and that importations of seed corn from a distance should be confined to a very limited area until, by careful selection, they have become adapted to local conditions.

9. That a maximum yield of corn can hardly be secured under good soil conditions in this state with less than 12,000 plants per acre. This stand may be had with three plants per hill, in hills 36 inches by 42 inches.